Ultra-Lightweight, High Efficiency Silicon-Carbide (SIC) Based Power Electronic Converters, Phase I

Completed Technology Project (2005 - 2005)

Project Introduction

This Small Business of Innovation Research Phase I proposal seeks to investigate and prove the feasibility of developing highly efficient, ultra-lightweight SiC semiconductor based power electronic converters for Earth science mission vehicles. With high temperature operation of power electronics components, heatsinking and active cooling thermal management strategies can be significantly downgraded; thus reducing the size, volume, and weight of the overall power electronic systems by as much as an order of magnitude. This would translate directly to savings in space launch costs and in improving vehicle payload capacity. SiC power devices have a theoretical junction temperature operational limit of over 600

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C, and with the recent advancement of these devices, high efficiency ultra-lightweight power electronics system will become a reality within the next 5 years. SiC power devices also offer other improved performance characteristics over their silicon counterparts, including 10x the blocking voltages, 10x the power densities, reduced switching losses, and improved switching frequencies up into the 10s of GHz range. Modularizing these SiC power converters for easy utilization in all facets of NASA vehicular power management and distribution applications would provide the potential for substantial financial savings, improved reliability, and improved performance.

Anticipated Benefits

The ability to operate at high temperatures and high power densities makes the SiC technology attractive for deep earth petroleum exploration equipment, military motor drive applications (such as for hybrid-electric combat vehicles), commercial fuel cell power converters, or upgrades to the national power grid. Longer term applications would be driven by reduced costs, where it is envisioned the technology will dominate the industrial machines motor drive markets with high efficiency, high power density, motor integrated solutions. Baldor Motors, one of the world's leading manufacturers of electric motors and drives, has shown great interest in the potential of this technology for the commercial market-place, and has provided a letter of support. The development of ultra-lightweight SiC power converters would find application in a number of NASA orbital, aerospace, marine, and deep space missions. These converters would offer volume, weight, and performance benefits for energy conversion power systems, including; solar arrays, fuel cell or battery banks, nuclear powered cores, or other power sources. The same technology could be used in a wide range of other power electronics systems as well, including DC actuator/motor drives for vehicle or spacecraft appendages, AC motor drives, and power distribution/protection systems.

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

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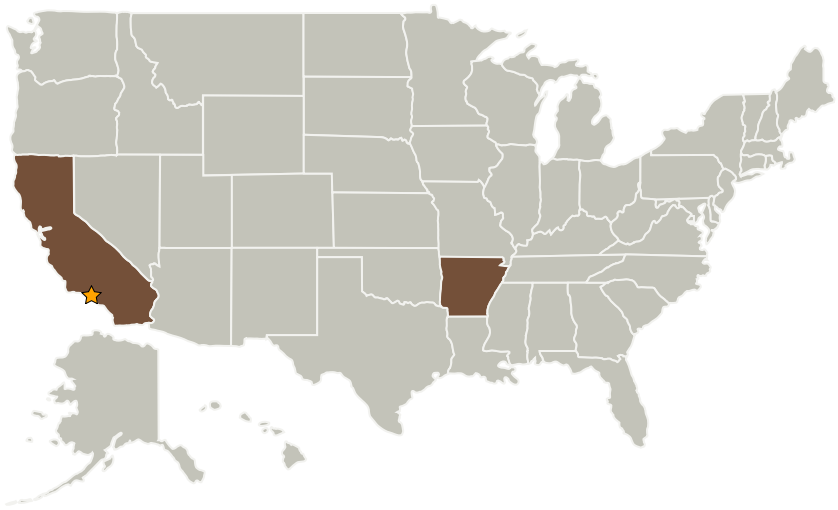
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California
Arkansas Power Electronics International, Inc.	Supporting Organization	Industry	Fayetteville, Arkansas

Primary U.S. Work Locations	
Arkansas	California

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Managers:

Mason A Peck
Celestino Jun Rosca

Principal Investigators:

Alexander Lostetter
Waleed Abdalati

Technology Areas

Primary:

- TX03 Aerospace Power and Energy Storage
  - TX03.3 Power Management and Distribution
    - TX03.3.3 Electrical Power Conversion and Regulation